Commercial Microencapsulation of Mixed Wastes – a Successful Technology Transfer

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ABSTRACT

During 1998, Envirocare of Utah, Inc. began treating certain mixed wastes with molten polyethylene in kinetic mixer. This newly approved technology is commonly known as polyethylene microencapsulation. Polyethylene microencapsulation is a technology used to achieve TCLP-based treatment standards for mixed or hazardous wastes similar to stabilization. This technology was developed by Brookhaven National Laboratory along with a similar technology which achieves polyethylene microencapsulation using an extruder. Brookhaven's research and development of waste treatment technologies are part of a continuous effort in DOE to find alternatives for their diverse mixed waste problems. Envirocare's process involves introducing waste and plastic into the kinetic mixer where kinetic energy is converted to thermal energy which causes the plastic to melt. During this process, the mixer also blends the waste and the plastic into a homogenous form that is subsequently discharged into a container where it cools. In the resulting waste form, the small-particle-size waste is encapsulated by molten plastic.

Samples of the microencapsulated waste are chemically analyzed using the TCLP test to verify that the waste meets RCRA treatment standards. Post-treatment testing has demonstrated that this process is an effective technology in the treatment of certain mixed wastes. Low-moisture-content mixed waste forms (e.g., nitrate salts, incinerator ashes, and many finely divided particulate wastes) are ideal candidates for this newly available technology. Other wastes, including sludges, may be treated with the kinetic mixer provided the wastes have been dried and sized prior to processing.

Envirocare of Utah, Inc. is a licensed and permitted treatment, storage and disposal facility which accepts LLRW, NORM, Mixed Waste and 11e.(2) uranium and thorium mill tailings. Since May 1995 when Envirocare's first treatment facility was permitted, several treatment technologies have been added to the Envirocare service list. The most recent addition is Microencapsulation using a kinetic mixer.

Developed by Brookhaven National Laboratory, Microencapsulation is a technology used on wastes to achieve TCLP-extract-based treatment standards. It involves finely dividing and combining waste with molten polyethylene to form a material that does not leach hazardous constituents in excess of established treatment standards. In a kinetic mixer, waste is placed into the mixer with polyethylene, a common plastic. The waste and plastic are mixed at a high frequency with shear and frictional forces that melt the polyethylene and mixes it with the waste to create a resulting homogenized waste form.

Technology Transfer

Envirocare has a successful history of technology transfer from Brookhaven National Laboratory (BNL) working through the DOE Mixed Waste Focus Area. Envirocare's first technology transfer from BNL was macroencapsulation in 1996. Envirocare offers a permitted and licensed treatment and disposal facility for this effort.

Envirocare continued to work with the DOE Mixed Waste Focus Area and considered the transfer of other technologies that could be commercially deployed to treat and dispose of DOE waste. In 1998, Envirocare began using BNL's microencapsulation process in a new treatment facility designed to accommodate this treatment method.

The technology transfer includes testing microencapsulation using two methods: the kinetic mixer and an extruder. The transfer process provides for a comparison of these methods to determine the most efficient and effective treatment method, a working microencapsulation process, and the technology's application to various waste forms. During this process, input from BNL, the Mixed Waste Focus Area, regulatory agencies, and outside consultants will be utilized. To date, only the kinetic mixer has been used to treat waste. The extruder has been used for the processing of surrogates for permitting purposes only.

Facility Design and Equipment

Envirocare's mixed waste facility is RCRA Part B permitted. A treatment building was constructed to house microencapsulation and other mixed waste treatment technologies. The building provides containment during the treatment process, storage capacity and negative pressure atmosphere controls. The building is located adjacent to the mixed waste disposal cell, providing quick and convenient disposal access following successful treatment.

A kinetic mixer and extruder are available for microencapsulation. Delivery systems include silos and conveyers for efficient waste handling and automated delivery. A waste dryer has been acquired to condition waste as needed prior to treatment. This process can increase the success rate of the treatment method and/or make the waste meet the physical requirements of treatment. Sizing, shredding, and screening equipment is also available to pre-treat waste for conformance to physical requirements.

Waste Types Suitable for Treatment

The first requirement for treatment acceptance is to meet Envirocare's waste acceptance criteria. This includes the RCRA Part B Permit and Radioactive Material License (renewed in October 1998).

Physical treatment criteria are also in place for each of the treatment methods. For the kinetic mixer, waste must have a maximum particle size of 16 mm and maximum moisture of 40 percent. For microencapsulation in the extruder, waste must have a particle size no greater than 3 mm and a moisture content no greater than 2 percent. Waste that exceeds the limits above may be considered for microencapsulation on a case-by-case basis. Treatment preparation for these wastes would include size reduction and drying.

Waste types which have been identified as the most suitable for microencapsulation are incinerator ash, powders, salts, and dried and finely divided soils and sludges. Minimal moisture content is preferred, and the waste should contain only trace organics.

Treatment Using the Kinetic Mixer

Envirocare first employed microencapsulation under a temporary permit from the State of Utah. Approximately 1,000 cubic feet of ash waste was treated in the kinetic mixer. The waste required treatment for hazardous metals, including selenium. Prior to microencapsulation treatment, stabilization methods had proven unsuccessful in treating the waste stream.

Treatment batches ranged from 5-20 pounds per batch, including plastic. Mixing time per batch was approximately 20-30 seconds. Envirocare achieved a treatment rate of approximately 250 pounds per hour. Waste loading ranged from 40-60 percent.

Envirocare verified treatment by sampling and analyzing the microencapsulation treatment residues in accordance with the frequency guidelines of the permit. Most samples were taken before final solidification of the waste form and formed into pellets for testing. TCLP testing was conducted and the waste shown to meet all applicable treatment standards and land disposal requirements.

Future Microencapsulation Prospects

Microencapsulation in the extruder has been tested using surrogates of sandblast grit, sand, rock salt and kiln ash. Final permitting of both treatment methods is anticipated by the end of 1998. After permitting, the next step is to use microencapsulation on DOE waste streams. Targeted wastes include incinerator ash from the WERF Incinerator at INEEL and incinerator ash from the TSCA incinerator on the Oak Ridge Reservation.